Lake Leota Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2009

Lake Leota

Prepared for the City of Woodinville
by the King County Lake Stewardship Program

January 11, 2010

King County

Overview

The King County Lake Stewardship Program (KCLSP) began working with volunteer monitors to monitor Lake Leota in 1998. In 2005, the City of Woodinville contracted with KCLSP to continue monitoring Lake Leota. The water quality data indicate that currently the lake has moderate productivity (mesotrophic) with good water quality.

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae that could be produced in the lake. A second measure is the nitrogen to phosphorus ratio (N:P), which is used to predict what groups of algae may become dominant in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2009 water year. Specific data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://www.metrokc.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx.

Or can be provided in the form of excel files upon request.

Physical Parameters

Excellent records of **precipitation** and **water level** were kept over the year by volunteer monitors. The lake level followed the typical regional pattern of winter high - summer low stands, with some sensitivity recorded to large rain events, particularly in winter (compare precipitation with lake level rise in Figure 1). However, the rise in lake levels in response to large rain events was temporary in each case and did not last more than a week or two after the events.

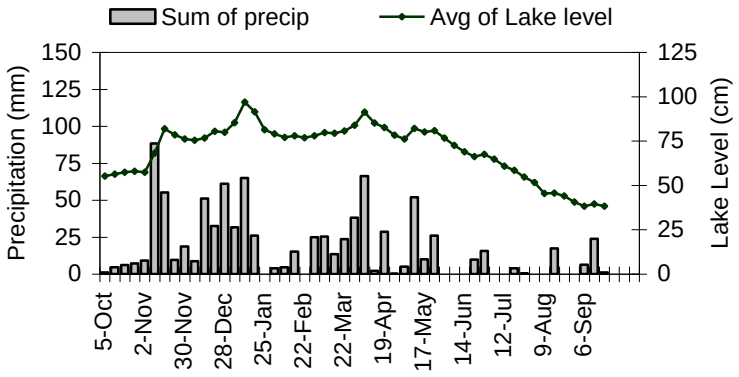

Figure 1. Lake Leota precipitation and lake level

Weekly data on **water temperature** were compiled throughout the 2009 water year by the KCLSP Level I volunteer, and water temperatures were also gathered by the KCLSP Level II volunteer from May through October. Water temperatures during the year followed a pattern similar to other lakes in the region, with cool temperatures in the winter and spring, followed by summer maximum temperatures occurring between mid-

July and mid-August, followed by progressive cooling in the fall (Figure 2). The water temperature at 1m ranged from 3.5 degrees Celsius to 27.0 degrees Celsius with an average of 14.5 degrees C over the year. There is a jump in temperature in early August after a hot spell in the Puget Sound lowland region that brought up lake temperatures across the region. Compared to other lakes monitored through the KCLSP, Lake Leota is in the lower range of summer temperatures.

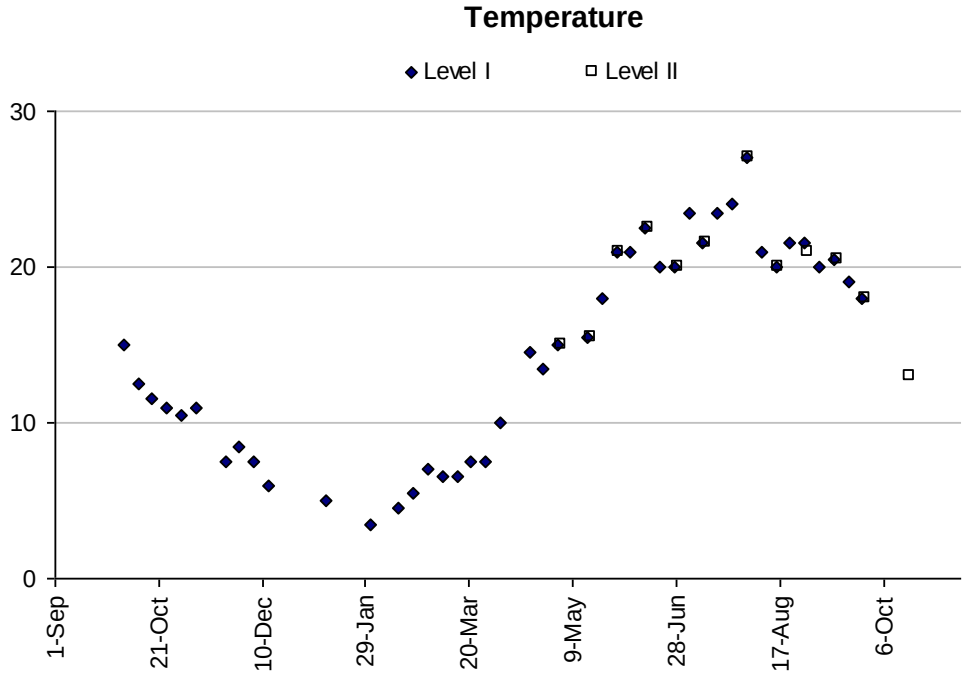

Figure 2. Lake Leota Water Temperatures

Secchi transparency is a method commonly used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface.

For Lake Leota, Secchi transparency values ranged from 1.9m to 5.0m, averaging 3.0m (Figure 3), with both observers in good agreement during the period of their overlapping observations. This is in the mid-range for clarity compared to other small lakes monitored by the KCLSP in 2009. Compared to data collected in previous years, the Secchi transparency values exhibited normal and expected variability until fall, when clarity increased dramatically in a manner unlike other recent years.

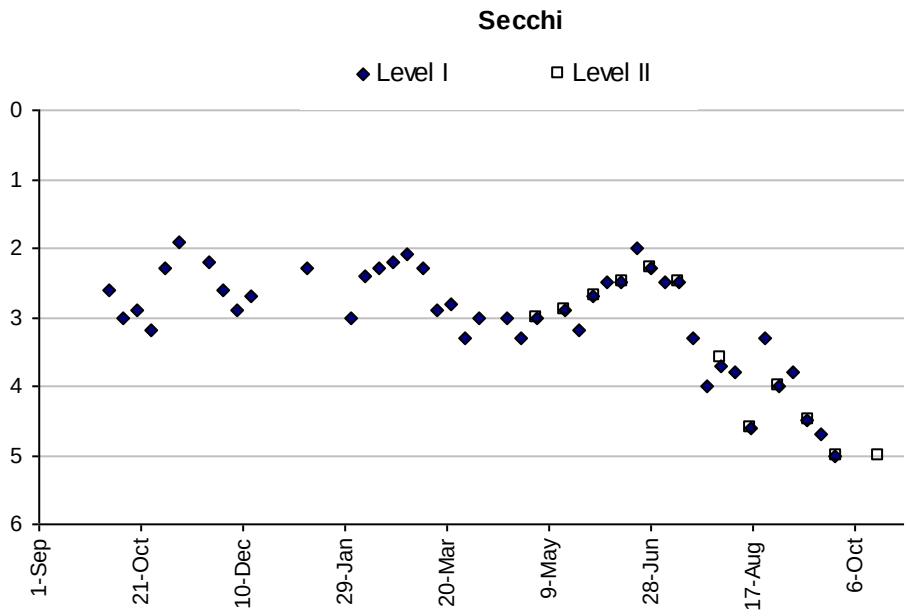

Figure 3. Lake Leota Secchi Transparency

Nutrient and Chlorophyll Analysis

Phosphorus and **nitrogen** are naturally occurring elements necessary in small amounts for both plants and animals for healthy growth and reproduction. However, many actions associated with residential development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity can be limited by the amount of available phosphorus at times during the year. Increases in phosphorus concentrations can lead to more frequent and dense algae blooms: a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins. Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth from May through October and a several depths twice during the period.

Total phosphorus (TP) and total nitrogen (TN) showed slightly different patterns through the May – October sampling period (Figure 4). In May, the TN started high and decreased through July, then was fairly even over the rest of the sampling period with a slight increase in October. TP values began fairly low and were stable through July, then increased concurrently with TN through the fall.

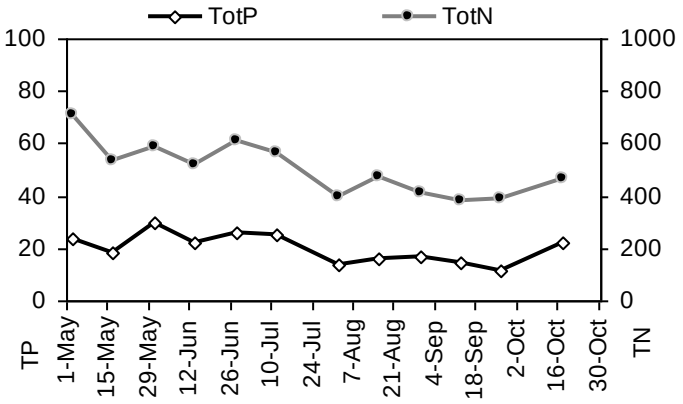

Figure 4. Lake Leota Nutrients

The ratio of nitrogen (N) to phosphorus (P) can be used to explore whether conditions were favorable for the growth of cyanobacteria (bluegreen algae), of which some species can impact beneficial uses of lakes. When N:P ratios are below 20, some cyanobacteria can dominate the algal community. The N:P ratio in Lake Leota ranged from 19.9 to 33.1 with an average of 26.0; the only time the ratio was below 20 occurred in late May. This suggested conditions in the lake may have been favorable for bluegreen algae in the earlier part of the sampling season, but generally were not conducive for a bluegreen bloom.

Chlorophyll *a* values varied greatly at Lake Leota during the first half of the monitoring season (Figure 5). There was one peak in late May and a larger peak in late June, with chlorophyll remaining very low the rest of the season. This suggests there was an abundance of phytoplankton in the lake in late spring, followed by low values for the rest of the year. The high water clarity in fall is consistent with that conclusion.

Pheophytin remained low and steady throughout the majority of the season.

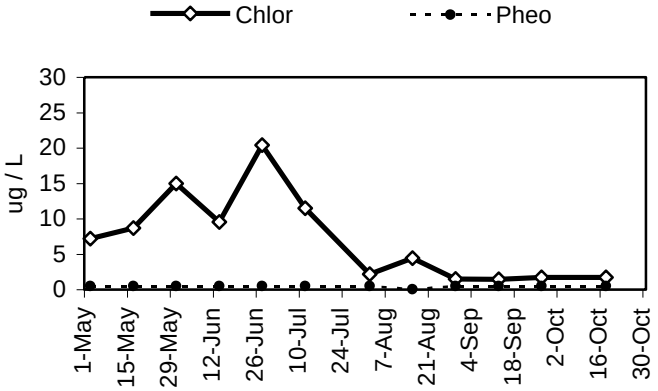

Figure 5. Lake Leota Chlorophyll *a* and Pheophytin Concentrations

Profile data indicate that thermal stratification was present early in the season and persisted through the summer (see temperature data, Table 1). In both of the deep water (6m) samples there were elevated levels of nutrients and ammonia, suggesting that the hypolimnion (bottom water) of Lake Leota is anoxic, causing phosphorus release from the sediments back to the water. On both occasions, chlorophyll was much higher in the

deep water than at 1m, suggesting that enough light was reaching the bottom for algae to grow more abundantly at depth in the lake than near the surface.

Table 1: Lake Boren Profile Sample Analysis Results

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NO2-3	NH3	Total P	OPO4	UV254	Total Alk
Leota	5/17/09	2.9	1	15.5	8.7	**<MDL**	0.532	0.105	**<MDL**	0.0180	**<MDL**	0.190	29.0
			3	9.0	14.5	1.4	0.621			0.0241			
			6	5.0	86.3		1.480	**<MDL**	1.040	0.0855	0.0201		
Leota	8/30/09	4.0	1	21.0	1.5	**<MDL**	0.415	**<MDL**	**<MDL**	0.0165	**<MDL**	0.176	34.4
			3	18.5	4.5	2.0	0.391			0.0216			
			6	6.5	248.0	ChlorB	3.140	**<MDL**	2.600	0.2620	0.0508		

The relatively low values for UV254 indicate that the water of the lake is clear, with little coloration from organic substances, while the total alkalinity values show that the water in the lake is relatively soft and lightly buffered from pH change. NOTE: In Table 1, <MDL stands for "below minimum detection level" of the analytical method.

TSI Ratings

A common method of tracking water quality trends in lakes is by calculating the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of the lake based on measurements of water clarity (Secchi depth) and concentrations of TP and chlorophyll *a*.

For Lake Leota, the indicators do not validate statistically any long term changes or trends over the time of measurement, with the average of the three TSI values between the high mesotrophic and low eutrophic threshold in each of the eleven seasons of monitoring (Figure 6). There is a visual suggestion of 2 periods of increase (1998-2001 and 2002-present), with a step-drop between 2001 and 2002. The correlation coefficient of the increase since 2002 is 0.6525, suggesting that the recent increase may be statistically valid, although several years more data would be needed to make the relationship robust.

The TSI-TP and Chlorophyll-a ratings match up very well in 2009 and are in the upper range of the mesotrophy, while the TSI-Secchi rating is a little lower. The average TSI value for 2009 in Lake Leota was 45.4, placing the lake solidly in the mid mesotorophic range.

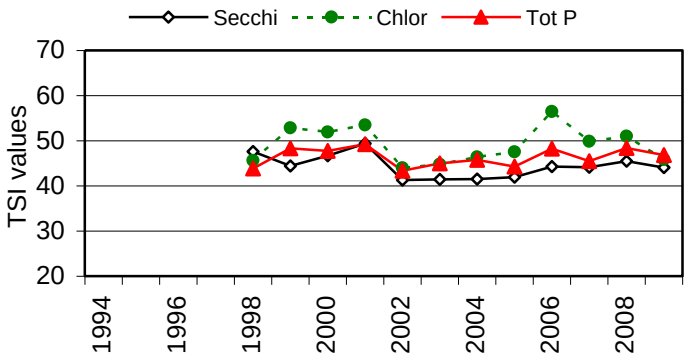

Figure 6. TSI Values at Lake Leota

Conclusions and Recommendations

Lake Leota has been mesotrophic for the last eleven years of sampling, although it has varied from year to year in its placement within the range. There may be a trend since 2002 for higher phosphorus values, suggesting the lake could be shifting towards eutrophic conditions, but the evidence is not strong as yet. The N:P ratios averaged just above 20 early in the season, with one dip below the 20 threshold in late May. This indicated that the conditions in the lake could have favored bluegreen algae blooms during that time. After May the ratios were higher, and conditions were probably unfavorable for bluegreen algae blooms.

Continued monitoring of nutrient and chlorophyll concentrations should be done to gain greater confidence on the apparent increase in total phosphorus, as well as looking for other indicators of water quality decline. Algae blooms in the future should be reported for evaluation by the Washington State Department of Ecology's Toxic Algae Monitoring Program to determine whether or not blooms at the lake may be producing toxins.